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ABSTRACT

This paper discusses the concept of Information Communication Technology (ICT) supported education at the university level, focusing on Moscow State University (MSU). The technology and functions of the high performance network of the Physics Department at MSU are first described. The information block development concept for implementing open distributed learning (ODL) is reported, and software standards for instructional materials are discussed. The ICT support of lecture courses and future ODL projects for MSU and Moscow elementary schools are described. (Author/AEF)

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Information Infrastructure of University Education

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Abstract: The concept of education with the Information Communication Technology (ICT) support for the university teaching level is presented. The high performance network of Physics Department at MSU is described. The information block development concept will be reported. The software standards for teaching materials are discussed. The ICT support of lecture courses experience and the projects of open distributed learning (ODL) for MSU departments and elementary schools are described.

Introduction.

The basis of university activity is a process of teaching, which is formed from methods and tools of education in art and science. At present time in tools and methods of education sufficiently rapidly enter the modern information technologies, changing our glances and beliefs about the most process of teaching significantly increasing its possibility and quality. Education processes to become more dynamic and information capacious and increasing the data transfer speed do it also distributed. Thereby, education becomes more available and uniform ensuring access the universities and knowledge, accumulated in its, to the wilder academic auditorium, which practically becomes the whole world.

Consequent growing of data transfer speed has brought about shaping the three speed feature levels: - 64 kb/s, 2-10 Mb/s, 100 Mb/s and above, to which are created and developed their own intellectual tools and network facilities. They accordingly form the media: of intellectual contacts, research and education. All these media interconnected are mutually enriched and bring about the consequent growing of the society potential and each of they are kept a process of learning.

Intellectual tools of each data transfer speed level are formed in accordance with possibilities of network facilities, i.e. issues of certain volume of information and supporting its software. The first level corresponds the process of formation exchange are used small amounts of traffic data, second level corresponds the research area when the amount of experimental and theoretical materials are significant. The third level is education and it works in multimedia mode transmitting and receiving a big volume of information.

Network facilities are a modem network, Ethernet, FastEthernet, Gigabit Ethernet and ATM with corresponding transport media: - telephone lines, coaxial cable, UTP and fiber optics links. And as a temporary, reserve communication facilities can be used microwave and satellite links.

Accordingly under each level are created and perfected software tools. Software, either as communication and network equipment passes a way of development standards and their approbation. Improvement and software development must go on way of maximum compression of data transfer given for the reason raising a quality and volume of information under minimum speed data transfer. This comprises of itself process of organizations of dataflows, textual search system development, and information packages compression and on physical and technological levels - an asynchronous issue, traffic checking and virtual network management. On this way can be provided reduction of data transfer speed and provided its maximum quality.

In our paper we will discuss a third level - education and will consider its intellectual tools and network facilities which are required for creation the education network of Moscow State University (MSU).

Education with ICT support of any level at modern stage logically is possible to support all "standard procedure" of learning process: lectures with audio- video conferences support, students classes with the system of interactive test, laboratory classes with the online experimental facilities, electronics library with the context search systems, advisory board network service and so on. So there are some opinion that it is the possibility of complete imitation of the elementary and higher education system.

In addition the relatively simplicity of the standard Web applications by the direct converting the text and multimedia files brings to force contamination of the information space and give the difficulties for the choice of really need elements from the suggested "swollen" network database. Therefore exist the real dangerous of the beginning of the cold information "cultural layer" on the way of the development of educational networking resources and as the result - "overflow" and the higher "noise level" in information background of networking support education system.

In our paper will be presented the conception of the universities education network, on the authors opinion permit to overcome the mention above the " baby diseases " of the development the open distributed education in Russia. As the illustration of the concept realization was chosen the Physics department at MSU, having more then five year experience in operation of network resources in education, research and management. It is as the proving ground of the development and testing of logical, hardware and software networking solutions for Moscow State University. The Physics department is the biggest department at MSU. It has 2500 students and 1500 staff members.

The development level and using the information technologies in science and education is defined by the main possibilities of university, country and the world to organize of high-speed performance external communication channels. The function of modern condition of data transfer speed mode of world telecommunication possibilities is shown on Fig. 1. Seen that speed performance mode of the world Internet users has a maximum in the region 100 kb/s while for full realization of educa-

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tion possibilities it must be well above. Full-fledged and active using the information technologies in education and research activity requires the following speed modes: in education before 1-10 Gb/s, for research - 10-100 Mb/s.

ICT education network initially requires high-speed performance network as far as exchange by information occurs in multimedia mode. From brought speed mode of world users follows that active using Internet for education only started and its undertaking requires presence to high speed performance network of university (100 Mb/s) and high-speed performance external channels (10 Mb/s and above).

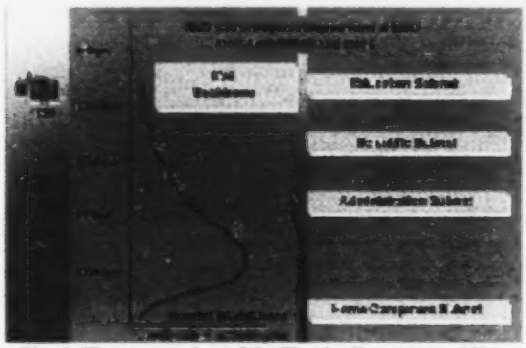

Fig. 1. The perspective of the Physics Department ICN.

Evolution of data transfer speed modes of telecommunication system of Physics department at MSU with 1992 on 1998 and distinctive speed area to their realization in different subnets on the medium 1998 is shown on Fig. 1. (By the symbol of the department and university). The modern status of Information Communication Network (ICN) of Physics department at MSU shows that the department is ready for active using the information technologies in education and research. The most further development of the department ICN will go on way of improvement only and increasing its powers and full-fledged exhibit development for scientific and education whole.

The Russia national academic networks have the following external channels possibilities: MSUnet - an overland channel - .5 Mb/s, FREEnet - an overland channel - 2 Mb/s, RUHEP/Radio-MSU - 1 Mb/s satellite link and 128 kb/s overland channels and RUNnet (Russian University Network) - 4 Mb/s satellite link and 6 Mb/s overland channels. Thereby for active using the information technologies in the education process it is necessary to increase Russia academic network channel possibilities.

However, the channel possibilities of Russia Universities allow already presently to begin a shaping the national network resources of education. High speed performance network with 1-10 Gb/s will require new approaches to shaping a topology and network architectures, but does not require education software products modernization, which were designed and used at a speed level given 100 Mb/s.

MSU United Telecommunication Information System.

In 1997 in the MSU was created United Telecommunication Information System (UTIS), which has united all communication and information facilities of the Moscow University. At present practically created the global university network infrastructure and were established the fiber optics transport media between MSU buildings located on Lenin's Hills and in the center of Moscow [1]. Thereby were created the united high-speed performance MSU transport media on ATM (155 Mb/s).

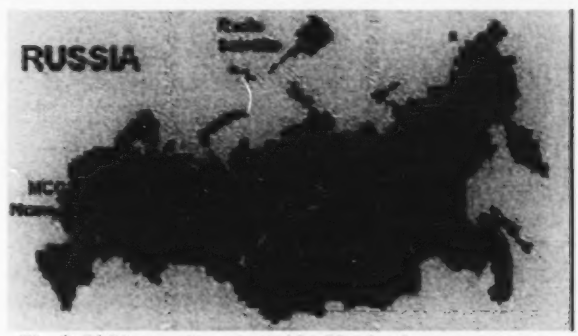

Fig. 2. RUNnet nodes operated by Physics department center.

Relationship with scientific-education Moscow's centers and Moscow region is realized by means of microwave facilities, located on high-altitude (200 meters) of Main MSU building and by the overland fiber optics links. In the MSU also are in operation Federal nodes of Moscow regional network RUNnet, which begin its functioning in the September 1994. Satellite antenna and operation node is located on Physics department and the control room is at MSU.

The Physics Department RUNnet center support the operation of high speed performance channel with regional academic-research centers (Fig. 2.) as Novosibirsk State University (128 kb/s), Ural State University (128 kb/s), Ul'anovsk State University (96 kb/s), Nizjny Novgorod State University (64 kb/s), Perm' State Technical University (256 kb/s). The satellite ground station is located on the Physics Department building. The information channel loading near 672 kb/s so will be possible to connect to the node another regions of Russia. The operation comes through the communication satellite "Raduga". The connection to the satellite supported by receiving-transmitting station for satellite communication "Kedr -M". The transmitter power up to 40 W and it permits to support the information channel up to 4 Mb/s. The data processing based on 5 satellite modems SDM of EF-DATA Company. The operation is on Cisco 4000 router.

Moscow University has direct access to Global Internet which at present established on channels to US (0.5 Mb/s), to Nordunet (through RUNnet), to Hamburg (1 Mb/s, through Radio - MSU). In combinations with rebuild overland RBnet channels, new Internet centers (on the program of Institute "Open society" and Ministry of Science of RF) these facility present itself perspective communication base for the beginning of shaping to educational network of national scale.

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Telecommunication system of MSU Physics Department.

The ICN of Physics Department on transport parameters is divided on LAN of the department, modern pool and external communication links [2]. LAN of the department based on Ethernet, Fast Ethernet and ATM topology with the thin coaxial cable, UTP and SM fiber optics as the transport media and consists from the several segments connected to Information Systems and Technology Center (ISTC). The ICN of Physics Department consists of three subnets: education, scientific and administration, working at low speed level (10 Mb/s) and high speed level (100 Mb/s) segments (Fig. 3.). Internal department network has before 600 computers in local network and more than 600 computers on modem connection.

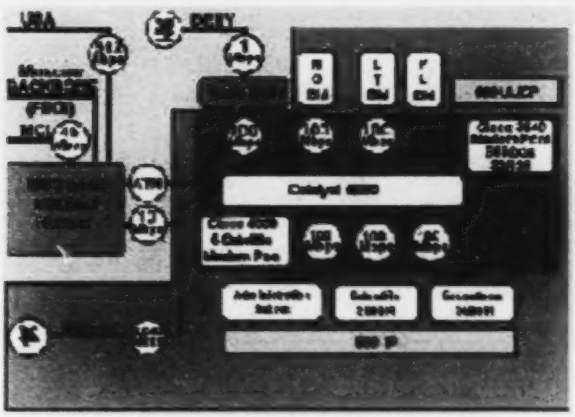

Fig. 3. Layout of MSU Physics Department ICN.

The sequential moving the ICN inside the department based on the subnode organization (at present time - 6) with the network routers and repeaters with the further ramification to network segments. The network protocol is TCP/IP it permit the naturally integrate the department network infrastructure directly to Internet.

The ICN scheme (Fig. 3.) includes two fiber optics link to MSU node, fiber optics links to remote Physics Department buildings as Nonlinear Optics Bld., Low Temperature Bld., Magnetism Lab. Bld and NPI MSU and internal network of the department LAN formed as three big subnets: scientific, education and administration.

If address to evolution of structure of network resources of ICN (Fig. 4.), conditionally possible select four greater stages. The first four years with 1992 on 1996 have left on making a network infrastructure and shaping its control center with ensuring a necessary service for network users. A making of a scientific department subnet on Ethernet topologies and its use for raising a scientific potential of the department.

In parallel with the development of network infrastructure increasing an entering the scientific employees and teachers in new for them world of information technologies. Practically for given periods were created necessary conditions of transition on high-speed performance links, but real they're mastering has begun in 1997. It was perfected technological and software aspects of using of communication, network and computer equipment for FastEthernet, conducted its testing and the development of optimum states of working. In this time occurred a consequent increasing a using the information technologies in education. Given period is characterized more deepened by using the information technologies in scientific functioning the employees and students.

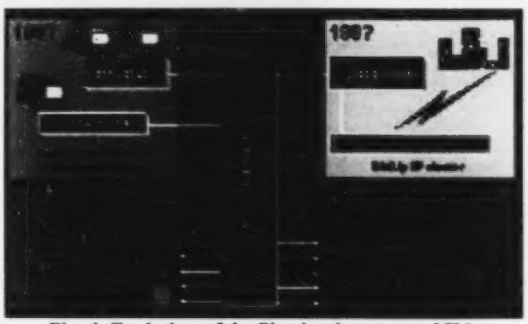

Fig. 4. Evolution of the Physics department ICN.

From February 1997 department ICN translated on transport media with the data transfer speed before 100 Mb/s and from summer 1997 on ATM (155 Mb/s). Parallel were laid fiber optics links to central department auditoriums. For the reliable operation to education network were also laid links on UTP, but used earlier coaxial cable lines were left as reserve. Commissioning of fiber optics links in central department auditoriums has allowed testing communication, network and computer equipment on 100 Mb/s from the level and realizing a maximum data transfer speed before 50 Mb/s.

Information blocks for ODL and standards of its presentation.

On the base on education ICT network of Physics department was started the checking of transport media structure, logic control, hardware and software testing for education ICT network university. It was begun wide scale introducing the information technologies in the teaching process and their active use in lecture courses and development standards teaching audio and video education materials.

The process of creation and development of the ODL system on the Universities of Russia level provide the simultaneously solution of fourth heterogeneous tasks:

- forming the transport media of Inter-network communications which give the possibility to realized already existed at present time all spectrum of network services in education;
- creation the conception of the network development from the position of selection the educational material and the form of its presentation;

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- establishing the standards of the presentation the network products on the software level support as "multiplatform" of working applications as the possibility of development of autonomy information analogues for the application in LANs;
- standards choice on the architecture, hardware and software support of Intra-network of the universities and another academic institutions.

The priority task of information support of the education process, accordingly the taken conception, is to summit the access to intellectual resources of the university teaching - educational network on the moment of the demand forming on educational service. Therefore under the choice of the technological solution for the architecture and hardware base of the communication system the main will be the realization practically direct regime access to "network teaching auditorium". On the technological level it correspond the high-speed performance of data transfer and data processing the creation the systems of loading the database array of the high volume.

The contents of the information resources of the open distance university education system first of all must to reflect the real educational, or more narrow - learning process [3-5]. The unity of the research and education activity which are inherent in university education, big volume of authorized original developments, mobility of the learning courses programs require in principle a different approach under the choice of the standards of the information processing such materials to compare with the fully developed standards of multimedia type as "electronics education books". Can be determine five main directions in information support of the education process oriented on different groups of the "listener":

- forming the information "mirror" of auditorium work of teacher;
- development accompanying information materials to support the teacher work;
- creation the On-line education "training machine" (local or global experimental facilities, model system);
- development the online and outline assistance system and knowledge testing;
- development and accompanying the unified database of the education materials.

The sequence of enumeration of the information resources correspond its priority for the developers and opposite priority for the users of the information accompanying of education system or system of open distributed education.

Weekly volume auditorium lecture hours, to which works in the mode online information support system forms 32 hours for cycles of physical profile and 38 hours with the account of mathematical and humanitarian cycles. Technological mode occupies not less than 400 hours for workstations and round-the-clock operation for servers group.

After the two years testing of information presentation for the education network of MSU were selected the next standards:

- *RealMedia - for the direct access presentation to lecture fund on humanitarian discipline,*
- *RealMedia and MPEG3 - for audio accompanying system for foreign language teaching (English, German, France for Russian students and Russian for foreign students),*
- *MPEG1 - for video accompanying of different education courses,*
- *JAVA - terminals to realized the online regime for work with remote access experimental systems,*
- *PERL - management for the interactive testing system and assistance,*
- *ORACLE - Database as an integrated base of education development of MSU and another academic institution of Russia.*

The standard selection for information blocks presentation were based on the criteria of compatibility with the different types of hardware and software configurations of the workstations of clients in different Russia regions, typical speed regimes of information exchange, the possibilities of creation of autonomous mirrors copies or CD - analogue of information blocks, the information security level and the prediction in the software development.

A high-speed performance segment department ICN establishing stimulated a spreading accumulated in the process of its usage's of experience on the connection of computer classes of department, which at given time were already modernized on multimedia computers presented by the "Intel" company. Were laid speediest communication links before language cabinets and library and in the near future they will be also enclosed in the education subnet. The computer classes used for educating the students to programming and numerical methods can be used as reference classes and classes of preparing the students to occupations. Language cabinets equipped computers and speediest access, - an active studying English language by Russian students and Russian language - by foreigners.

ODL for Moscow State University and Moscow elementary schools.

In 1998/99 academic year is offered to conduct a joint experiment of Physics, Geology, Chemistry Departments and Department of Basic Medicine (Fig. 5.), supported by MSU transport media. The software development, computer, communication and network equipment will be tested for whole remote teaching on courses "General Physics", "Ecology" and "Foreign Language" [4].

On the first stage will be established single mode fiber optics links to auditoriums specified department, adjusted and installed communication and auditorium equipment (workstation and multimedia projector), formed servers part of education segments of departments network and tested technological and transport media.

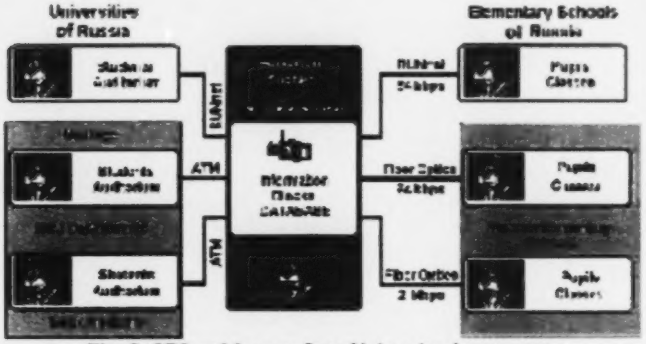

Fig. 5. ODL at Moscow State University departments.

Practical functioning is expected to begin from remote educating with teaching interactive materials opened by bases of on courses general physics. Professors of Physics department, delivering the lecture in general physics courses to students of specified departments will use illustrative materials from databases of education server of Physics department and Internet. Will be tested inter department network cannel's possibilities, tested their speed modes and worded requirements for MSU education network.

On each department will be formed the groups of professors, which proceed with the information blocks development on under study subjects (geology, chemistry, medicine) and delivering the lectures with the ICT support. Also will be designed the standards and requirements of granting in MSU education ICT network materials for making the databases on their specialties. In parallel will be tested database Oracle-8 and determined standards on client and server part. Will thereby begin a shaping an education information space of Moscow University, which hereinafter can use MSU departments and Russia universities.

Presented desirable to conduct an experiment on remote educating from MSU to one of the Russia University. This will allow to perfect mechanisms of access from education network of MSU to universities of Russia, including the RUNnet facilities and thereby begin a shaping of information educational space of Russia, i.e. national information network resources of education.

Consequent development and a filling education ICT network at the MSU departments will allow to create the archive of teaching materials with high speed access facilities. At present in different countries have proceeded with the development of such powerful devices of keeping and distribution information. Such - Warehouse - can be designed and created in the new building of library on the new MSU territory. Hereto time will already be perfected and designed corresponding shaping facility, keeping, searching and sharing a big volume of information with the high speed access with MSU departments and Russia universities.

Physics department this year plans an undertaking an experiment in Moscow elementary schools with the software development, computer, communication and network equipment testing for whole remote education on courses "General Physics", "Astronomy" and "Ecology".

Undertaking such experiment requires presence several components to its successful realization. First, it is necessary to choose schools of city having potential technical possibilities for a given experiment. Secondly, in chosen schools must be a teaching staff adequately accompany on the experiment and having for this corresponding qualification.

For the experiment were chosen two school close work with MSU Physics department, where occupations on the physicist from Physics department and Moscow City Palace of Creation of Children and Youth on Lenin's Hills (MCPCCY), with which have the good relationships with the Physics department. As a transport media will be used SM fiber optics links with speed transfer from 64 kb/s to 100 Mb/s.

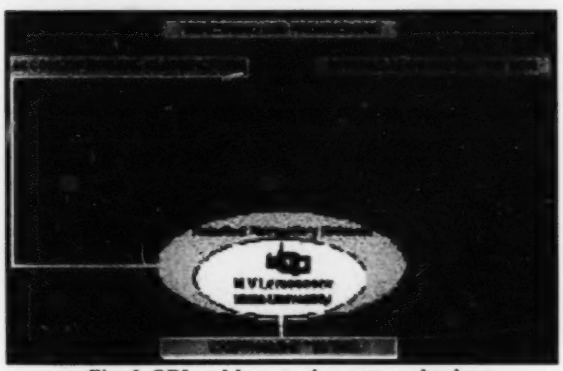
Fig. 6. ODL at Moscow elementary schools.

The project will consist from two parts (Fig. 6.). The first will be the development and creation technological and transport media with remote educating with teaching interactive material opened by bases of on courses general physicists with physics department in schools 1134 and 1189. The second one will be shaping under MCPCCY the communication node for service and accompanying as a segment of Moscow elementary school's network.

On the first stage are perfected technical and technological questions, is installed servers and communication equipment and is educated operating personnel, is formed teaching staff for the occupations with schoolboys on different professions and begins development of methodical and teaching materials for educating the schoolboys.

In MCPCCY before the October-November 1998 will be created server cluster for servicing and accompanying to information network of elementary schools with consequent

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connecting of first two schools, but then, on the measure of increasing of communication and network equipment and other schools of Moscow. Parallel in MCPCCY will be also conducted learning the schoolboys on "General physics" and "Astronomy" with development methodical and teaching materials.

In 1996/97 academic year near 10 schools Moscow were connected on UUCP to ICN of Physics department, but they are basically introduced with functioning an e-mail and in different information networks and databases. Shaping in education subnet department materials, calculated on the different speed performance mode of data base communications, without their quality loss, will allow to perfect mechanisms of transfer a teaching material on modem network of department that will serve a central to granting the educational materials on home computers of schoolboys and all wanting. Creation in the composition of education subnet of the department - DIAL UP IP will allow to begin a remote education on low speed performance (before 64 kb/s).

Conclusion

The undertaking described above experiments will allow proceeding with shaping university and school educational networks in Moscow with further access on Russia telecommunication possibilities. Will thereby be fixed a relationship before higher education and higher education levels for the reason raising a quality of education on the base of modern information technologies and making an uniform education to different teaching discipline in Russia.

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